

HEMATOPOIETIC STEM CELL THERAPY AS A COUNTER-  
MEASURE FOR HUMAN EXPLORATION OF DEEP SPACE.

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Human exploration of deep space depends, in part, on our ability to countermeasure severe/invasive disorders that astronauts experience in space environments. The known symptoms include hematologic/al/cardiac abnormalities, bone and muscle losses, immunodeficiency, neurological disorders, and cancer. Exploiting the extraordinary plasticity of hematopoietic stem cells (HSCs), which differentiate not only to all types of blood cells, but also to various tissues, we have advanced a hypothesis that some of the space-caused disorders may be amenable to hematopoietic stem cell therapy (HSCT) so as to maintain astronauts' homeostasis. If this were achievable, the HSCT could promote human exploration of deep space. Using mouse models of human anemia ( $\beta$ -thalassemia) as well as spaceflight (hindlimb unloading system), we have obtained feasibility results of HSCT for space anemia, muscle loss, and immunodeficiency. For example, in the case of HSCT for muscle loss, the  $\beta$ -galactosidase-marked HSCs were detected in the hindlimbs of unloaded mouse following transplantation by X-gal wholemount staining procedure. Histochemical and physical analyses indicated structural contribution of HSCs to the muscle. HSCT for immunodeficiency was investigated using  $\beta$ -galactosidase gene-tagged *Escherichia coli* as the infectious agent. Results of the X-gal staining procedure indicated therapeutic role of the HSCT. To facilitate the HSCT in space, growth of HSCs were optimized in the NASA Rotating Wall Vessel (RWV) culture systems, including Hydrodynamic Focusing Bioreactor (HFB). (Supported by NASA: NIAC/NAS598051 and USRA/NCC9142)